(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 March 2001 (01.03.2001)

PCT

(10) International Publication Number
WO 01/15205 A1

(51) International Patent Classification[7]: H01J 61/86, 61/18, 61/30, 61/82

(21) International Application Number: PCT/EP00/07514

(22) International Filing Date: 2 August 2000 (02.08.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
99202749.0 25 August 1999 (25.08.1999) EP

(71) Applicant: KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors: HENDRICX, Josephus, C., M.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). CARUSO, Nancy, J.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). PEELAERS, Kurt, J., A.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). DUIVELSHOF, Veronique, E.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(74) Agent: DUSSELDORP, Jan, C.; Internationaal Octrooibureau B.V., Prof Holstlaan 6, NL-5656 AA Eindhoven (NL).

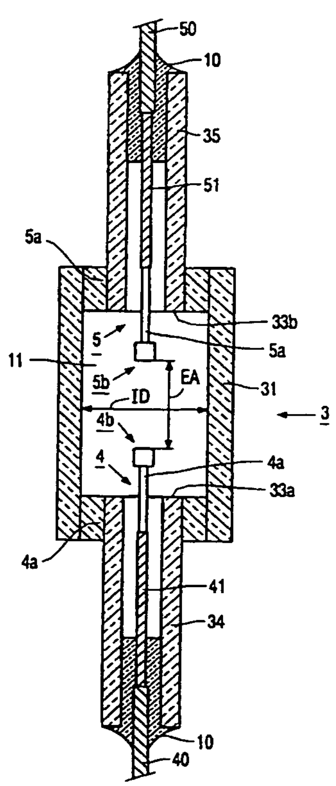
(81) Designated States (*national*): CN, JP.

(84) Designated States (*regional*): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published:
— *With international search report.*
— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METAL HALIDE LAMP



(57) Abstract: The invention relates to a metal halide lamp having a nominal power of more than 100 W, comprising a discharge vessel with a ceramic wall. The discharge vessel encloses a discharge space having an ionizable filling which, in addition to Hg, contains a quantity of iodide of Na, Tl, Ho and Ca. Two electrodes each having an electrode tip at a mutual distance EA are arranged inside the discharge vessel. The discharge vessel has a cylindrical part with an internal diameter ID and extends through at least the distance EA. According to the invention, the relation EA/ID<1 is satisfied.

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Metal halide lamp

The invention relates to a metal halide lamp having a nominal power of more than 100 W, comprising a discharge vessel with a ceramic wall enclosing a discharge space containing an ionizable filling which, in addition to Hg, comprises a quantity of iodide of Na, Tl, Ho and Ca, and in which two electrodes are arranged, each with their electrode tip located at a mutual distance EA, said discharge vessel comprising a cylindrical part having an internal diameter ID and extending at least through the distance EA.

A lamp of the type described in the opening paragraph is known from WO 98/45872 (N16313). The known lamp has a high specific luminous flux and, in operation, emits light at a high color temperature T_c and a value of at least 90 for the general color rendering index R_a.

In this lamp, use is made of the recognition that a satisfactory color rendition is possible when Na halide is used as a filling constituent of a lamp and when, during operation, there is a strong widening and reversal of the Na emission in the Na-D lines. This requires a high temperature of the coldest spot T_{kp} in the discharge vessel of, for example, 1170 K (900 °C). When reversing and widening the Na-D lines, these assume the shape of an emission band in the spectrum, with two maxima at a mutual distance $\Delta\lambda$.

The requirement for a high value of T_{kp} excludes the use of quartz or quartz glass for the wall of the discharge vessel and necessitates the use of ceramic material for this wall.

In this description and the claims, a ceramic wall is understood to mean both a wall of metal oxide such as, for example, sapphire or densely sintered polycrystalline Al_2O_3, and metal nitride, for example, AlN.

Although the known lamp has good color properties and a relatively high luminous flux, the lamp has relatively large dimensions. Concentration of the light to a beam emitted by the lamp, for example, by means of a lens or a diaphragm for projection purposes thus results in a relatively large loss of light. This is a drawback.

It is an object of the invention to provide a lamp of the type described in the opening paragraph, in which the drawback is obviated to a considerable extent.

According to the invention, this object is achieved in that the lamp of the type described in the opening paragraph is characterized in that the relation $EA/ID<1$ is satisfied. An advantage of the lamp according to the invention is that the light emitted by the lamp can be better concentrated to a beam, while, surprisingly, it is also possible that the luminous flux and the color temperature T_c decrease in value only to a small extent while maintaining the value for the general color rendering index R_a. The lamp according to the invention is suitable, inter alia, as a light source for coupling light into a light-conducting fiber. A decrease of the ratio EA/ID below 0.65 generally leads, in the case of a constant ID, to an unacceptably low specific luminous flux of the lamp. An improvement of the lamp according to the invention is possible when the lamp has a wall load of at least 110 W/cm^2. Wall load is herein understood to mean the quotient of the lamp power and the inner surface of that part of the discharge vessel which extends through the distance EA. It is thereby achieved that, in the case of coupling light into an optical fiber, a better coupling efficiency can be realized, which leads to a higher system efficiency.

In a further variant, the ionizable filling also comprises iodide of Dy and Tm. A lamp with a color temperature $T_c \geq 4{,}000$ K is then possible.

The lamp is preferably provided with an outer envelope enclosing the discharge vessel with a space. The space is preferably filled with an inert gas, for example N_2. The gas in the space has a cooling effect on the wall of the discharge vessel. In the operating state of the lamp, the pressure of the inert gas is at least 100 Mbar and preferably not more than 1 bar in order that risk of explosion is excluded. There is preferably a minimum distance of 3 mm between the outer envelope and the wall of the discharge vessel. At distances of less than 3 mm between the outer envelope and the wall of the discharge vessel, it appears that the wall of the discharge vessel is cooled less effectively. A reduction of the distance below the minimum distance is a drawback in practice because of the positioning of a current conductor to one of the electrodes of the lamp. A further increase of the distance only results in a small increase of the cooling effect.

A wall thickness of between 0.6 mm and 1.4 mm appears to be advantageous for realizing an optimum temperature distribution across the wall of the discharge vessel. A wall thickness of less than 0.6 mm has the drawback that the temperature of the wall of the discharge vessel will become unacceptably high so that the lifetime of the lamp is influenced detrimentally. Generally, a strong temperature gradient which is unwanted for a desired

lifetime of the lamp will also occur across the wall of the discharge vessel. An increase of the wall thickness above 1.4 mm leads to a strong decrease of the specific luminous flux.

A suitable temperature gradient across the wall of the discharge vessel is achieved in a preferred embodiment of the lamp according to the invention when the cylindrical part with an internal diameter ID extends between end faces at a mutual distance of at least 2*EA. In a further embodiment, the discharge space enclosed by the discharge vessel is sealed at the area of the end faces.

Preferably, such a value of the coldest spot temperature T_{kp} is realized that the value for $\Delta\lambda$. ranges between 10 nm and 30 nm.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawing:

Fig. 1 shows a lamp according to the invention,

Fig. 2 is a cross-section of a discharge vessel of the lamp shown in Fig. 1.

Fig. 1 shows a metal halide lamp comprising a discharge vessel 3 shown not to scale in a cross-section in Fig. 2, which vessel has a ceramic wall enclosing a discharge space 11 which contains an ionizable filling comprising, in addition to Hg in the case shown, a quantity of iodide of Na, Tl, Ho and Ca. Two electrodes 4, 5, each of W in the drawing, are arranged in the discharge space, with electrode bars 4a, 5a and with an electrode tip 4b, 5b each, located at a mutual distance EA. The discharge vessel comprises a cylindrical part having an internal diameter ID and extending between end faces 33a, 33b and at least through the distance EA. The discharge space enclosed by the discharge vessel is sealed at the area of the end faces 33a, 33b.

The discharge vessel is sealed at one end by ceramic projections 34, 35 which extend as far as the end faces 33a, 33b and narrowly enclose, with an interspace, current lead-through conductors 40, 41 and 50, 51 connected to the electrodes 4, 5 arranged in the discharge vessel, and connected thereto in a gastight manner by means of a melt-ceramic compound 10 proximate to an end remote from the discharge space. The discharge vessel is enclosed by an outer envelope 1 provided at one end with a lamp base 2. In operation, a discharge extends between electrodes 4, 5. Electrode 4 is connected via a current conductor 8

to a first electric contact which forms part of the lamp base 2. Electrode 5 is connected via a current conductor 9 to a second electric contact which forms part of the lamp base 2.

A practical embodiment of the lamp described above has a nominal power of 150 W. The electrode distance EA is 6 mm, the distance between the end faces 33a, 33b is 14 mm and the internal diameter ID is 6.85 mm. The ratio EA/ID has the value of 0.86, which complies with the EA/ID<1 measure according to the invention. The ceramic wall of the discharge vessel has a thickness of 0.8 mm. In operation, the lamp has a wall load of 116 W/cm^2. In addition to Hg, the ionizable filling of the discharge vessel with a pressure of 32 bar in the operating condition comprises 8.5 mg of iodide salt of NaI, TlI, HoI_3 and CaI_2 with percentages by weight of 55, 13.5, 16.5 and 15, respectively. In operation, the lamp has a lamp voltage of between 90 V and 95 V. In operation, the lamp emits light at a specific luminous flux of 89 lm/W, a color temperature T_c of 3000 K and a general color rendering index value R_a of 92. The value for the coldest spot temperature T_{kp} and for $\Delta\lambda$. is 1220 K and 20 nm, respectively.

For use as a light source for an optical fiber, the lamp is placed in an ellipsoid reflector having a focal length f of 18.8 mm and an aperture diameter of 83.9 mm, and is provided with a dichroic coating having a reflection coefficient of at least 0.9 for the wavelength range between 400 nm and 650 nm. The optical fiber has a diameter of 15 mm. In these circumstances, the coupling efficiency is 22.5% and the specific luminous flux of the system is 19.5 lm/W.

In another practical embodiment of the lamp according to the invention, the discharge vessel has an identical construction. The ionizable filling comprises Hg with a filling pressure of 24 bar in the operating condition and 8.5 mg of iodide salt consisting of NaI, TlI, DyI_3, HoI_3, TmI_3 and CaI_2 with 13.7, 8.6, 11.7, 11.7, 11.7 and 42.6% by weight, respectively. The lamp has a specific luminous flux of 88 lm/W, a color temperature T_c of 4000 K and a general color rendering index value R_a of 94. In operation the lamp has a voltage of 109V, whilst the value for the coldest spot temperature T_{kp} 1299 k is and for $\Delta\lambda$ 12.5 nm.

CLAIMS:

1. A metal halide lamp having a nominal power of more than 100 W, comprising a discharge vessel with a ceramic wall enclosing a discharge space containing an ionizable filling which, in addition to Hg, comprises a quantity of iodide of Na, Tl, Ho and Ca, and in which two electrodes are arranged, each with their electrode tip located at a mutual distance EA, said discharge vessel comprising a cylindrical part having an internal diameter ID and extending at least through the distance EA, characterized in that the relation $EA/ID<1$ is satisfied.

2. A lamp as claimed in claim 1, characterized in that the lamp has a wall load of at least 110 W/cm^2.

3. A lamp as claimed in claim 1 or 2, characterized in that the ionizable filling also comprises iodide of Dy and Tm.

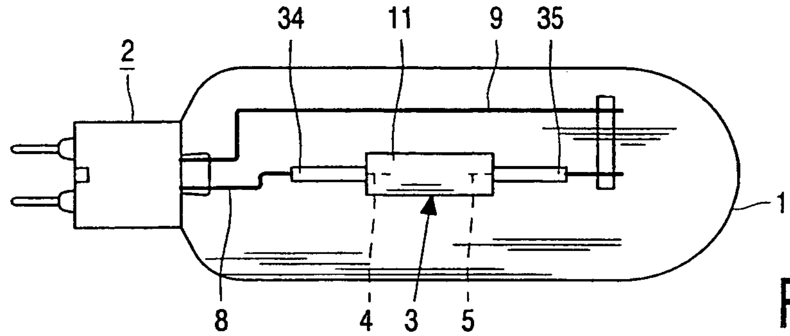
4. A lamp as claimed in claim 1, 2 or 3, characterized in that the lamp is provided with an outer envelope surrounding the discharge vessel with a space, and in that the space is filled with an inert gas.

5. A lamp as claimed in claim 4, characterized in that, in the operating state of the lamp, the pressure of the inert gas is at least 100 mbar and preferably not more than 1 bar.

6. A lamp as claimed in claim 4 or 5, characterized in that there is a minimum distance of 3 mm between the outer envelope and the wall of the discharge vessel.

7. A lamp as claimed in any one of the preceding claims, characterized in that the wall thickness of the discharge vessel ranges between 0.6 mm and 1.4 mm.

8. A lamp as claimed in any one of the preceding claims, characterized in that the cylindrical part with an internal diameter ID extends between end faces at a mutual distance of at least 2*EA.



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11
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3
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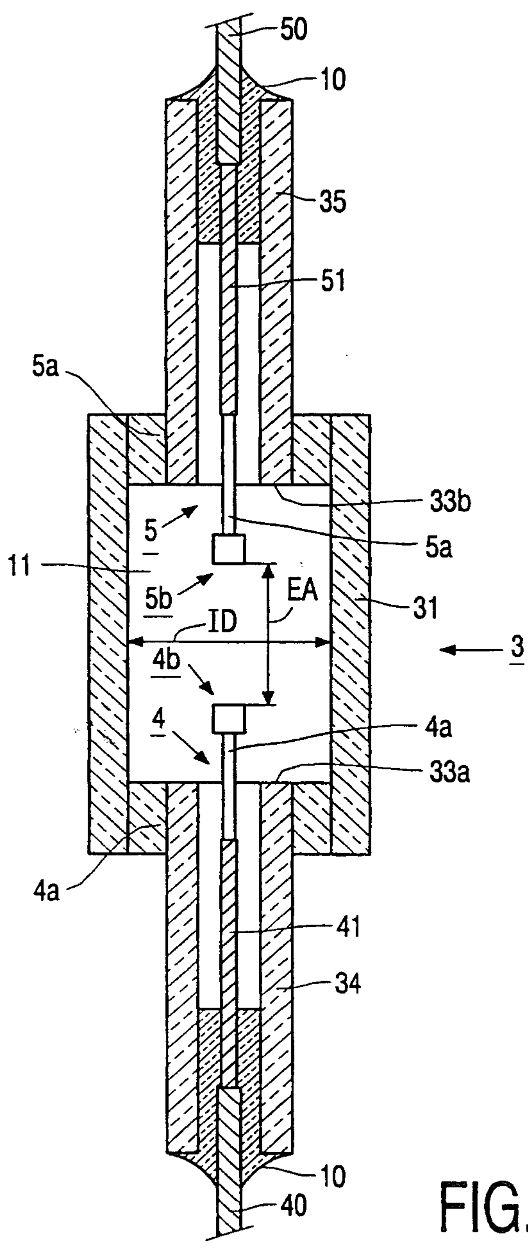
FIG. 1



50
10
35
51
5a
33b
5
5a
11
5b
EA
31
ID
3
4b
4
4a
33a
4a
41
34
10
40

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/07514

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01J61/86 H01J61/18 H01J61/30 H01J61/82

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	EP 0 807 959 A (GEN ELECTRIC) 19 November 1997 (1997-11-19) page 3, line 38 -page 6, line 54; figure 2 ---	1-8
Y	WO 98 45872 A (KONINKL PHILIPS ELECTRONICS NV ;PHILIPS NORDEN AB (SE)) 15 October 1998 (1998-10-15) cited in the application the whole document ---	1-8
A	DE 37 16 485 C (W.C. HERAEUS GMBH) 24 November 1988 (1988-11-24) claims 1,4-6; figure 1A ---	1-3,6-8
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 January 2001	19/01/2001

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/07514

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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International Application No
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